Heller and Brightley's New Transit.

The Engineers and Surveyors' Transit as at first constructed commonly termed a "flat centre," or "Railroad Transit," although superior to the English Theodolite which it superseded, yet in practice has been found defective in the following mechanical details.

1st. The upper or vernier plate, resting and turning upon the under or graduated limb, was accompanied by so much friction, caused by the large extent of the rubbing surfaces, that in turning the vernier plate around the limb, the whole instrument would sometimes be moved upon the lower spindle.

2d. The oil that was necessarily used to lubricate the plates, would become so congealed in cold weather that the plates would not move at all, and old Railroad Engineers will readily recall the thawing out of their instruments over large fires, at every fall of the thermometer, before they could be used.

3d. The spindle upon which the entire instrument turns, being detached from the instrument, thus violating one of the standard rules, that by long experience in this country and Europe, has been found necessary in the construction of any instrument with any pretensions to accuracy, viz.: "*any instrument having a graduated plate and levels should be so constructed that both of the centres upon which the instrument turns should be always covered and not detachable from the main plates.*" To prove the utility of this rule, it is only necessary after adjusting the levels of one of this class of Transits so that they will reverse on the top centre, to clamp the two plates together, and turn the instrument on the lower spindle, and the levels will invariably be found out of adjustment, showing conclusively that through some cause, most frequently the settling of flying dust, etc., upon the surface and shoulder of the spindle, the spindle is not at right angles to the surfaces of the plates.

4th. The centre around which the graduated limb revolves can only be the thickness of the graduated limb; this centre by reason of its small surface wears after comparatively short use, and does not exactly fit the conical hole in the graduated limb, and two readings of the same object taken without any change in the position of the instrument have been found to differ by 5′, and from no other cause than this.

These various defects have caused this style of instrument to be entirely discarded in city work, and for this another construction is used in which the two main plates do not touch each other, thus obviating the two first evils, viz.: the friction of the two plates rubbing one over the other, and the stiffness of motion of the plates in cold weather. The sockets and spindles upon which the main plates revolve being long and fitting

one inside of the other, and neither of them being exposed or detached from the instrument, thus remedying the two last causes of error. These two are the only styles of Transit made, and are respectively termed the "short centre Transit" and the "long centre Transit." The "long centre," although the most perfect in its construction, has never been a favorite among Railroad Engineers for the following reasons :

1st. The increased size of the centres making it heavier, and this being a very serious objection where an instrument must be carried several miles every day as is frequent in Railroad surveys.

2d. The instrument not being detached from the tripod, except at the base, compelled the Engineer in moving the instrument from one station to another to either carry the entire instrument himself or trust it to his assistant, while in the short centre, the instrument lifting off the spindle, the Engineer could take the comparitively light instrument with all the important parts, and leave his assistant to carry the heavier portion of the tripod with its leveling screws, legs, etc.

3d. The removing and replacing of the instrument on the tripod being accomplished by means of a large screw thread, is a very tedious and unsafe method, and if not very carefully performed is liable to injure the instrument.

4th. The extra skill, time, and care required in making the long centre was so much greater than the flat centre, that the price of the instrument was materially increased.

Ever since the introduction of the Transit numerous endeavors have been made to reduce the weight of the instrument, but as they have all been conducted on the same principle, *i. e.*, reducing the thickness of the various plates, etc., their only effect was to make the instrument so slight as to be unsteady, their bearing surface so short as to soon wear loose, and the instrument always losing its adjustment. The manufacturers of this instrument have had their attention drawn to the increased strength and steadiness that the employment of the "transverse section," "ribbing or bracing," imparted to metals; and the amount of metal that could be removed from a solid plate of metal, and its strength and steadiness not impaired, but even added to, if only judicious ribbing was resorted to. In this improved Transit, which is a long centre, the weight as compared with an ordinary Transit of the same size is reduced one-half, and the instrument is not contracted in any part, but in some parts where increased size would be an advantage, such as the graduated plate, centre, etc., it has been done, but all the plates, etc., are ribbed in such a way as to be stronger than a solid plate, and all metal that did not impart either strength or steadiness has been removed.

The Railroad Engineer has in this instrument a long centre Transit that can be taken from off the tripod and replaced in a quicker and surer

way than the short centre Transit, but unlike the short centre, keeps all the centres covered and not removable from the instrument, and leaves the tripod head and legs with the four levelling screws, etc., to be carried by his assistant. The difference in weight will be appreciated by the Railroad Engineer when we inform him that a plain Transit with all its centres, etc., only weighs about as much as a Surveyor's Sight Compass, and is more steady and keeps in adjustment better than the ordinary long centre transit, weighing from 25 to 30 pounds.

The City Engineer has in this instrument all the advantages of the ordinary "long centre Transit" with only half the weight, and an increase of steadinsss.

There are several defects that are common to all Transits, among which are—

1st. The "tangent or slow motion screw" that moves the upper or vernier plate, by use becomes worn and does not fit precisely the thread in the interior of the nut through which it passes. When this occurs the tangent screw can be turned sometimes a complete revolution without moving the vernier plate. This "lost motion" or "back lash" of the tangent is one of the worst annoyances of Engineers, aud has been the source of serious errors in the field. Several methods have been devised to overcome this which we will here describe. The nut through which the screw works has been made in two sections to allow of being drawn together when the screw wears. This plan would answer if the screw always wore equally in every portion of its length, in other words was a cylinder, but this it never does, and if the nut is tightened so that the lost motion is removed from the thinner portion of the screw, it will move so tightly as to be useless when it comes to the portions that are not worn so thin. There are several methods of drawing the nut together, but they have all the same objections as the above, that is, they are not effective in the entire length, and the nut must be pressed so very hard on the screw as to make the working of the tangent very tense, especially in cold weather. Another, and the last method has been to apply a long spiral spring between the nut and the head of the screw that acts as the finger piece, thus pressing the nut and the screw from each other, and consequently removing all "lost motion" from the screw. This plan though in theory very good, in practice has been found inoperative, for the following reason: the spiral spring had of necessity to be made long enough, and stiff enough, to act in every portion of the screw's length, the alternate opening and closing of the spring by use weakened it, and in a short time it failed to remove the "back play." To get rid of this defect of "lost motion" in the tangent screw, opposing or butting screws have been sometimes substituted, but in use they do not give satisfaction, as two hands must be employed in using them, and standing from the edge of the plate, they are liable to be injured by blows, and they are apt, unless very carefully used, to throw the instrument out of level.

In this instrument we have an improved tangent screw ; that no matter how much the screw may wear by use, or time, will never get "lost motion," but will instantly obey the slightest touch of the hand : this is effected by means of a long cylinder nut, from the interior of which two-thirds of the screw have been removed ; into half the recess thus left in the nut, is nicely fitted a cylindrical "follower," with the same length of screw thread as the nut ; this follower is fitted with a "key," that prevents it turning in the recess, but allows motion in the direction of its length. A strong spiral spring is placed in the remaining half of the recess, between the fixed nut and the movable follower, and the spring has always tension enough to force the follower and fixed thread in contrary directions, and thus to remove any "lost motion" that may occur in the screw. It will be observed, that in this method the spring always remains in a state of rest, instead of closing and opening, as has been the case in all other applications of springs, and which have been the cause of their failure. Tangent screws that have had as much as 10′ play, have been made to work entirely taut by this method.

The mode of attaching the tangent screw to the plates in this instrument is entirely new—it is a miniature modification of the "Gimbelling" of a ship's compass, and allows the tangent screw, by its free swivelling, to be tangent to the plates in every part of its length, and thus never to bind. This tangent screw is also of value for sextants, astronomical instruments, &c., where lost motion is detrimental, and a smooth, easy motion is required.

In all instruments, the brass cheeks in which the three legs of the tripod play, are fastened to the lower parallel plate by a number of small screws, commonly twelve. When the legs wear in the cheeks, and become unsteady, the only method the Engineer has of tightening the legs, is by drawing the cheeks, in which the leg moves, by means of the bolt that passes through the leg ; this, of necessity, draws the cheeks out of perpendicularity, and strains the small screws that bind the cheeks to the parallel plate so much, as frequently to loosen them. This source of instrumental error hardly, if ever, occurs to the Engineer, but very good instruments have been condemned as unsteady, when an examination has shown the fault to be the above. This source of error can never occur in this instrument, as the cheeks and the parallel plate are made in one solid piece.

But to come to the last and most serious evil. The effective power of the Telescope is impaired by spherical aberration ; that is, the field of view, as seen in the Telescope, is not a perfect plane or flat, but is spherical. To prove this, take an ordinary telescope, and focus it so that an object will be clearly defined at the intersection of the cross hairs or the centre of the field of view, then, by means of the tangent screw, bring the same object to the edge of the field of view and it will be found in

every case to be indistinct and not in focus; on the contrary, focus it so as to be distinct at the edge, and it will be indistinct when brought to the centre. In some telescopes, however, it is impossible to focus at the outer edge of the field, and objects will be tinged with prismatic colors, showing that these glasses are affected by chromatic aberration also; sometimes the cause of this defect lies in the object glass, but in the majority of cases, the lenses composing the eye-piece are in fault.

These aberrations affect the working of the telescope in several ways. First, it practically diminishes the size of the object glass, and the view is never so clear and distinct as it ought to be. Second, It is very difficult, and in some cases almost impossible, to adjust the eye-piece to prevent parallax, or "travelling" of the cross wires, when the eye is shifted from side to side; and practical engineers know what a sharper power of defining, and how much less trying to the eyes a "soft glass" has—that is, one that has a "flat field."

This defect has prevented the general use of the Stadia, or Micrometer wires, as a method of measuring distances without a chain, as the two horizontal hairs that are used, being in diffrent parts of the field of view, can not, in a majority of cases, be focused so as to be devoid of parallax, and the slightest travelling of the wires in this operation will give an erroneous result.

The evils of this defect were most forcibly brought to Mr. Heller and the late Wm. J. Young's notice, when one of their best Transits failed to define in tunnel work, from loss of light, from this cause, and they both endeavored, to within a short time of Mr. Young's death, to remedy it, trying all the known formulas of almost all the opticians in the country, but without any good results.

In the Telescope of this instrument these evils are entirely removed, by the employment of a new eye-piece, and advantage has been taken of the improvements that Optics have made in the last few years, in the curvatures and arrangements of the lenses that compose it; and the test referred to above, of focusing an object in the centre of the field of view, and then bringing the same object to the edge, and it still remaining in sharp focus, can be done with this telescope, and the object shows no tinge of prismatic color, showing that both chromatic and spherical aberration have been removed.

The advantages of this improved Telescope are: a clear and sharply defined field of view; a field of view so flat that the cross hairs are without parallax in every part of it, and micrometer hairs or Stadia can be used with favorable results.

The whole effective power of the object glass being used and none of the light lost, work can be commenced earlier in the morning and continued later in the afternoon than is usual. This, in the winter season, is

no slight matter to the engineer, and lastly, there is no straining of the eyes in sighting.

The spider's web, by reason of its fineness, is the only article hitherto used for cross hairs, yet in use these have been attended with some difficulties: first, the spider's web is hygrometric, or is affected by the humidity of the atmosphere—when exposed to dampness lengthening, and of course throwing the line of collimation from its true place. This defect is more serious in the Engineer's Levelling Instrument than in the Transit, instances being known where the line of collimation has altered two or three times in the course of ten hours, by reason of atmospheric changes, and of course any observations taken at those times would be defective; lastly, the spider's web being a transparent and not an opaque substance, in some positions it is impossible to see the hairs at all—this is more especially the case when sighting in the direction of the sun; that is, an easterly course in the forenoon, or westerly in the afternoon.

To remedy this defect, platina cross hairs $\frac{1}{1000}$ of an inch in thickness, or as fine as spider's web, are substituted; these being opaque, and not transparent, in sighting in the direction of the sun are still visible, and any atmospheric changes, dampness, &c., do not affect them. We believe that we are the first ones in this country who have drawn wire so thin, and the only ones who have made any practical use of Dr. Wollaston's experiment. The platina hairs are invaluable in Mining and Tunneling Instruments, that are so constantly exposed to dampness, and being opaque, no reflector to illuminate the cross wires is required.

To prevent the stiffness of working of the leveling, tangent and other screws in cold weather, which arises from the congealing of the grease that is used in lubricating them, no oil is used upon the screws of this instrument, but they are lubricated with pure plumbago.

By a simple arrangement of the clamps on the axle of our complete Transits, we make them also answer the purpose of a pair of Compass sights, for taking offsets at right angles to the telescope.

From the above, it will be seen that this instrument has the following improvements over the ordinary Transit:—1. A simple, secure and steady method of attaching and detaching from the tripod, being the only long-centre transit made that detaches as easily as a short centre. 2. An important decrease of weight, without decrease of size, and an increase of steadiness. 3. All the working parts of the tangent screw, &c., brought within the plates, making the instrument more compact. 4. An improved tangent screw, telescope, cross hairs and tripod head. 5. A pair of sights for taking offsets; and 6. A new method of lubricating the screws.